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THE COMPUTER AS AN AID TO INSTRUCTION AND GUIDANCE IN THE SCHOOL.

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COMPUTER APPLICATIONS IN EDUCATION ARE DISCUSSED IN TERMS OF--(1) A DESCRIPTION OF COMPUTER-ASSISTED INSTRUCTION (CAI) AND COUNSELING, (2) THE NUMBER AND TYPES OF COMPUTER-ASSISTED DEVELOPMENTS, (3) THE NATURE OF THE PENN STATE UNIVERSITY PROGRAM, (4) TENTATIVE RESULTS OF EXPERIMENTATION USING CAI, AND (5) IMPLICATIONS AND PROJECTIONS FOR THE FUTURE. CAI IS INDIVIDUALIZED, ENABLING A STUDENT TO RESPOND INDEPENDENTLY AND PROGRESS AT HIS OWN RATE. AS A METHOD OF INSTRUCTION, IT MUST BE CONNECTED TO SOME DEVICE TO PREMIT STUDENT-PROGRAM INTERACTION. FEEDBACK IS IMMEDIATE, WITH THE CORRECT STUDENT RESPONSE NECESSARY TO PROCEED. ALTHOUGH COMPUTER-ASSISTED GUIDANCE EFFORTS ARE IN THE DEVELOPMENTAL STAGES, ONE PILOT PROJECT DID RESULT IN CHANGES IN THE OCCUPATIONAL ATTITUDES AND VALUES OF JUNIOR-HIGH SCHOOL STUDENTS. A STUDY AT PENN STATE UNIVERSITY REPORTED FAVORABLE STUDENT REACTIONS, BUT NO DIFFERENCE IN LEARNING OR RETENTION BETWEEN CAI, LECTURE, OR SELF-STUDY METHODS. THE POTENTIAL OF CAI TO HUMANIZE RATHER THAN DEHUMANIZE EDUCATION IS DISCUSSED. THIS PAPER WAS PRESENTED AT THE REGIONAL SEMINAR AND RESEARCH CONFERENCE IN AGRICULTURAL EDUCATION (ITHACA, N.Y., NOVEMBER 8-10, 1967). (PH)

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THE COMPUTER AS AN AID TO INSTRUCTION AND GUIDANCE IN THE SCHOOL

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This paper focuses on five areas within the general field of computer applications in education:

1. A general description of computer-assisted instruction (CAI), and computer-assisted guidance and counseling.
2. A discussion of the number and types of computer-assisted developments currently underway across the nation.
3. The nature of the program at Penn State University.
4. Tentative results of experimentation and field trials using CAI and other computer applications.
5. Some implications and projections for the future.

On the copy of this paper which is available to you if you wish a copy I have underlined "assisted" when I mentioned computer-assisted instruction and guidance previously. The reason for emphasizing these systems as essentially supportive and supplemental to the teacher or counselor in the educational process is that it is this particular feature which is disregarded by most critics. The major attacks on computer-assisted instruction and guidance focus upon the non-humanistic nature of these systems. I contend that these systems may well become the most humanizing element ever introduced into American education. I will amplify this notion in the last section of this report.

Before embarking upon a description of computer-assisted instruction and guidance I believe it is necessary for us to keep in mind their twofold objectives. Their first objective is that of providing an effective instructional or guidance tool. The

second objective is that of developing an effective research vehicle. Of primary interest to most universities is the latter objective, while our schools, state departments of education and various profit-making institutions are focusing on the former objective.

Currently an unusual state of affairs exist -- there appears to be some balance of efforts in the two directions. There are already indications, however, that in the near future this situation will be altered considerably. You know better than I which way the scales are bound to tip.

General Description of Computer-Assisted Instruction and Guidance

CAI is an individualized method of instruction whereby a computer by means of some student-subject matter interface equipment elicits student responses to questions it presents, processes those responses, and based upon some decisions model proceeds to other materials in the programmed sequence. To get a better idea of the nature of CAI let's discuss this rather lengthy description in parts.

First, it is individualized. That is, a student allowed to progress at his own rate. In addition based on a students' history of responses (did he answer the last question correctly--the last two--at least three of the last five?) the student is led through a programmatic sequence which should result in the greatest amount of student learning. The extent of individualiza-

tion in any program is dependent upon the author of the program, the computer language he is using and the variety of interface devices available.

Second, CAI is a method of instruction. It is a way of teaching some specified content to some specified group in order that certain specified learning objectives are met. Our predominant orientation to categorizing subject matter by courses rather than by learning objectives may well interfere with our comprehension of this aspect of CAI. A CAI program in modern mathematics may not fit into any of our defined notions about a course for college freshmen, or one for high school juniors. It is rather defined by a specific set of objectives. The objectives of the program should be largely dependent upon a broader set of objectives developed by a teacher or group of teachers in a specified subject matter area. Primary consideration must be given in allocating objectives to the CAI program which of the objectives can be most appropriately handled by the computer.

Third, in order to operate,the computer in the CAI system must be connected to some device so that the student will be able to interact with the program. These devices are known as the student-subject matter interface. They are exemplified by the two-way typewriter, cathode ray tube, slide projector and tape recorder. They provide the input and output whereby the communication between the student and the subject matter take place.

Fourth, most CAI programs proceed in such a manner that a student is forced to answer each question posed or he won't be able to go on. In fact, he must produce the right answer (eventually it is usually presented to him). The overt act of constructing the correct response to an inquiry has in many cases proven to be an asset to learning.

Fifth, an essential feature of CAI programs is immediate feedback. That is, when a student responds correctly to an inquiry it is indicated that he is right. If the student answers correctly he may be asked to reconsider his answer, told he is wrong and to try again, or provided with the right answer and asked to supply it.

Finally, CAI programs are usually constructed to progress on the basis of some decisions model. If a student misses two consecutive questions in a certain segment of the programmed material he may be branched to a series of remedial frames. The decisions model, programmed by the course author spells out the criteria for such activities as branching to remedial segments of the program, moving on to more complex materials, or branching to final test items.

There are probably as many hardware configurations currently in use as there are CAI installations. The essential elements in all of them, however, are a number of remote student terminals connected to at least a medium-size computer in which are stored instructional programs. The distance between the remote

terminals and the central computer varies between the various installations around the country. Until recently Florida State University operated terminals which were connected to the IBM Watson Lab located at Yorktown Heights, New York. At Stanford University, because of the use of the cathode ray tube interface the distance between the terminals and the computer can be no greater than 1,000 feet.

CAI has preceded efforts in guidance and counseling by at least three years. In fact,computer-assisted guidance and counseling hasn't even adopted a mnemonic. There are currently only two operating computer-assisted guidance and counseling systems in existence in the country. Much of what has been said about CAI including hardware configurations, the twofold objectives of research and development of an effective tool, and an individualized approach can be repeated for computer-assisted guidance and counseling.

Extent of Current Efforts

Recently Donald Reynolds, Director of the Instructional Systems Institute of Texas Christian Institute conducted a survey to determine the extent of CAI involvement of colleges, universities, school districts, profit-making institutions and non-profit-making institutions(7). As of July, 1967, Reynold's survey revealed that 26 CAI systems were operating. It was also found that 29 additional systems were on order and would

probably be operating by June, 1968. On the basis of this data and other recent reports by Entelek Incorporated (3,7) and in the September, 1967 Educom Bulletin (1) I would say that conservatively there are today no fewer than 35 CAI systems currently operating.

According to Reynolds, as of July, 1967, there were 124 full-time professional staff working on CAI installations, 152 part-time professional staff, 341 full-time computer programmers, 233 part-time programmers, 109 graduate students, 445 full-time sub-professionals and 233 part-time sub-professionals. When totalled, the figures for number of personnel involved in CAI activities runs to over 1600. Within a year of the date of the survey it is expected that the number of staff will increase by over 120 per cent. As of July, 1968 then the figure should reach approximately 3,500.

Of the 55 CAI installations currently operating or being planned Reynolds reports that 18 indicated that basic research was their primary goal, 23 indicated that their primary concern was applied research, and 12 stated that their major emphasis was in curriculum development. The college student population was, as may be expected, the group to whom an over-whelming majority of the efforts were directed. The primary level population and the secondary level population were about equal in number of applications. Other special applications of CAI were reported

in teacher training, other professional training, special education and business and industrial training.

In the most recent issue of Educom (1) there are reported several CAI activities currently underway at the U.S. Naval Academy, Florida State University, University of Oklahoma Medical Center, Carnegie Tech, Wayne State University, and the State University of New York at Stony Brook. CAI News (7) reports CAI activities at Seton Hall University, Columbia University and the State Education Department of New York in a contractual agreement with Systems Development Corporation.

To give you an idea of the diversity of these efforts a brief description of the efforts mentioned is presented below.

U.S. Naval Academy - a configuration of twelve IBM 1500 terminals connected to an IBM 1800 computer -- provision for multi-media capability including closed circuit TV, image projection, tape recordings and programmed texts.

University of Oklahoma Medical Center - teach public health.

Carnegie Tech - industrial administration.

Wayne State University - psychiatry.

Florida State University - CAI covers a whole instructional spectrum -- from science for elementary school children and physics for non-science majors to a graduate course in social welfare. High school dropouts are coached in basic reading and math in an adult literacy project.

SUNY at Stony Brook - programs available in French, German, and statistics.

Seton Hall University - CAI program being developed to teach Chinese to prospective teachers of Chinese.

Columbia University - expects to be operating nearly 200 teletypewriters and cathode ray tube terminals on its campus by mid-1969.

State Education Department of New York - high school biology teachers in Albany were trained during the summer in the use of CAI teachniques. SDC, under contract with them, is exploring the feasibility of developing four CAI biology lessons.

Another important aspect to consider in examining the growth of CAI activities may be seen in a recent decision by the Office of Education. The USOE has awarded two contracts, one to IBM Corporation and the other to General Learning Corporation (7). The purpose of both contracts is to define the optimum design for a CAI system with 100,000 terminals located within a radius of one hundred miles. The parameters include:

a. terminals to be located within 50 buildings for youngsters in grades 9-11.
b. problem solving capabilities
c. use in data-processing training
d. administrative functions
e. cost of instruction not to exceed $.40 per student hour.

In awarding these contracts the Office of Education has apparently projected the continued vast growth of CAI.

There are several computer-assisted developments underway at this time which could prove to be of great use to the guidance counselor in complementing his current activities. Those I will mention are vocational guidance aids rather than educational or personal guidance aids. Two closely related reasons why the area of vocational guidance is currently attracting the attention of researchers are: (1) the problems are more acute than in the other areas -- the typical academic counselor bound by middle class values and unwilling to cope with problems of career development -- the changing nature of the world of work with its increasing demand for technological knowledge on the worker; and (2) the stimulation of research funding from the 1963 Vocational Education Act.

David Tiedeman and his associates at Harvard are developing an Information System for Vocational Decisions (ISVD) in cooperation with the Newton, Mass. school system and the New England Educational Data System (Needs). When operational as a prototype system (projected July, 1969) it will make use of student and worker characteristics, facts about occupations, education, military service and family. These facts will be placed in computer storage and anyone from a third grader to a 60 year old bricklayer out of a job will be able to make inquiries of the computer through some type of console device, test out tentative decisions on it, and obtain feedback from it.

Frank Minor at IBM working with Donald Super and Roger Myers

of Columbia are developing a computer-assisted vocational guidance program utilizing similar equipment as the Penn State operation (IBM 1050 terminal connected with an IBM 1400 series computer). The approach they have taken is to proceed with a twelfth grade youngster from his knowledge of various aspects of the world of work, exploration of the concepts of field of work and level of work, and then eventually to discussions of specific occupations within certain fields and levels.

William Cooley, formerly of the American Institutes for Research and now at the University of Pittsburgh has developed a computerized scheme whereby youngsters (ninth through twelfth graders) can obtain actual probabilities of their chances of success in any one of six major fields of work. These data have been developed on the basis of the Project Talent results.

Computer-Assisted Instruction and Guidance Efforts at The Pennsylvania State University

CAI. Currently in operation at Penn State is a hardware configuration of eight IBM 1050 terminals (four of which are located at University Park and four in field locations) tied to an IBM 1410 computer located at University Park by means of telephone lines. Three major activities are being conducted: curriculum development research, computer systems development and research and learning research.

Curriculum development research is being conducted in the areas

of: communication skills, mathematics and physics for technicians; instrumental music (teaching of the clarinet); audiometry; sixth grade spelling; and the identification of malaria parasites. Recently completed at Penn State was a CAI project conducted by Mitzel (5) in developing and presenting four college courses by computer teleprocessing. The college courses were: modern mathematics, speech pathology and audiology, cost accounting and engineering economics. Results of the field trials of these courses will be discussed in a later section of this report.

Attacks on problems in learning research recently reported by the CAI staff at Penn State include:

1. Gradient- and Full-Response Feedback in Computer-Assisted Instruction (6).
2. Relative Effectiveness of Various Modes of Stimulus Presentation through Computer-Assisted Instruction (6).
3. Remedial and Review Branching in Computer-Assisted Instruction (6).
4. Expressed Student Attitudes Under Several Conditions of Automated Programed Instruction (6).
5. Feedback, Prompting and Overt Correction Procedures in Nonbranching Computer-Assisted Instruction. (6-Bib.)

COAG. The first phase of the computer-assisted occupational guidance program in the Department of Vocational Education at Penn State is currently being field-tested. The purpose of this initial phase is to develop and evaluate a system of presenting

occupational information to ninth grade pupils, utilizing the computer-assisted instruction facility currently available. This system will provide a model for a more extensive, extremely flexible, easily updated information-giving system.

One of the most unique features of this system is that of selective presentation of occupational information. The selection of the materials to be presented to the individual student is based on that student's General Aptitude Test Battery (GATB) profile which is stored in the computer memory. Another of its unique features is the manner of presentation of the materials. Not only are materials typed out at the console where the student is to be seated, but also is presented on sound recordings and slide projections, all integrated under computer control.

This system is visualized not as a substitute for the counselor, but as an effective complement to the counselor. It provides the function of information-giving, that portion of the vocational guidance process which counselors are admittedly less adept to handle, and more willing to delegate.

The computerized occupational information system may be thought of as a powerful tool of the school counselor in the vocational guidance process. The school counselor must become actively involved if this "tool" is to be effective. Outside of the vocational guidance process the system has little utility. The system thus will function effectively only in a school where the guidance counselor acknowledges the value of vocational guidance

for ninth grade pupils and recognizes the need for them to acquire knowledge about occupations.

The unique advantages of the computerized occupational information system are its flexibility and its storage capacity. Its flexibility allows for unnumerable changes in the existing system -- changes in certain aspects of existing job descriptions such as educational requirements, employment outlooks, or work hours per week; the addition of new job descriptions; or the deletion of certain jobs which are being phased out of existence.

The practically limitless storage capacity of the system allows for many job descriptions to be stored in addition to innumerable characteristic student profiles. Any changes that occur in jobs and employment opportunities as well as up-dated student information can be immediately entered into computer storage.

In what ways will the computer-based occupational information system more adequately meet the needs of ninth grade pupils? First, since the interaction is with the student, independent of counselor involvement, all students will be offered the opportunity to obtain occupational information, not only those selected students for whom the counselor has time available. Second, the occupational information that is presented to the students will be accurate and up-to-date, resulting in the more realistic transmission of opportunities in the world of work. Third, the manner of presentation of the occupational materials via typewriter, tape recordings, and slide projections will

instill greater pupil interest, and consequently greater pupil growth in knowledge of the world of work. Finally, the selective nature of presentation of the occupational information will result in pupil acquisition of a more adequate picture of himself in relation to the world of work.

Through the development of the system including only a limited number of occupational groupings and specific vocational trade and industrial job descriptions to be presented to ninth grade pupils, it is expected to establish a prototype for a more comprehensive system in the future. Each pupil using the system is allowed to cover as many specific occupations as he has the time and the inclunation. Each grouping and specific job he does review, however, will be presented in relation to his own aptitudes and interests. The materials presented is thus pertinent, meaningful occupational information.

The result that is expected is the more realistic, intelligent choice of a vocational goal to give some meaning and direction to the rigorous training and/or rigcrous educational pursuits involved in attaining such a goal

In the spring of 1967 we tried out a tentative program at Kieth Junior High School in Altoona, Pennsylvania with about 75 ninth grade boys who were selected because they had indicated some interest in a vocational or technical training curriculum at the senior high. The program included descriptions (including slides and recorded interviews with workers) of 40 occupations.

The reactions we received from this group of boys was quite interesting. They felt that the information they received was quite helpful to them. They told us not to get too excited about the slides and tapes we presented -- it was the typeout that they felt was more interesting and important to them. They felt that the length of each session they had at the terminal was much too short (40 minutes). They indicated a preference for one to one and one/half hour sessions at the terminal. We are currently trying out another version of this program with a group of 150 ninth grade boys at Roosevelt Junior High School in Altoona. We also are developing a program which includes a more representative sampling of occupations divided into occupational categories.

Hopefully within the next five years we will not only have developed an operational guidance tool but will also be able to provide evidence related to its effectiveness and applicability at the various stages of career development.

The second phase of our computer-assisted occupational guidance effort is to develop sequential programs for seventh, eighth, and ninth grade boys and girls. Each program will be an outgrowth of the previous programs, proceeding from the general to the specific.

Constant feedback has been palnned for our field trials in the form of student reactions, counselor reactions, changes in student attitudes and values, and eventual performance of students

in their senior high school program.

Results of Research

Computer-assisted guidance efforts are still primarily in the developmental stages. It is thus apparent that little research data exists. The data from our spring pilot project in Altoona appears to be, in fact, the only such data available. That data does at least indicate that our efforts are perceived as beneficial, and the CAOG program experience does result in changes in students' occupational attitudes and values.

In searching through the literature I did locate an interesting piece of research conducted by Gilbert and Ewing at the University of Illinois (2). It has some definite implications for our work in computer-assisted guidance. One of the stated objectives of the study was "to discover whether the personal relationship factor present in normal face-to-face counseling situations and absent, to a very high degree, in a counseling book is an important variable." It was stated in the summary of the report that,

> While it cannot be concluded that the personal relationship factor is totally unimportant, it can be concluded that the personal relationship factor has been overemphasized in teaching, counseling, and probably psychotherapy. Consequently, teaching machine procedures are feasible in these situations where the personal relation-

ship factor has been considered necessary.

Part of the Penn State study to develop four college CAI courses (5) involved field trials. Data is presented in the final report on the speech pathology and audiology course segment and the engineering economics course segment. Each of the two field trials was conducted in the same manner. Twenty-one students were randomly assigned to one of three treatment groups -- the CAI method and the lecture method or the self-study method. No significant differences in learning nor retention was found in either trial between the methods. With only seven students within a treatment group the results reported are not surprising.

Generally favorable student reactions to CAI were reported in the study (5). Slightly negative reactions of students to CAI were expressed in terms of its inflexibility, the lack of opportunity for discussion and its tension arousing tendency.

It was also reported in the study that students with poorer Scholastic Aptitude Test (SAT) scores performed more poorly than those students with higher SAT scores, and displayed more of a negative attitude toward the method . From correlational data which was computed it appears to be likely that the poorer attitude of the low SAT students was the result of their poor performance rather than the result of their lower ability.

Strum and Ward (10) attempted to evaluate over a six month period the potentialities of CAI in the environment of engineer-

ing education. The authors concluded that "CAI has little to offer in the environment of the engineering classroom that is both real and superior to parallel techniques."

The Role of Computer-Assisted Instruction and Guidance in the Future

The current role of computer-assisted instruction and guidance is that of an experimental tool. It is useful to the researcher who is interested in exploring strategies of instruction and learning. This would still be its primary role even if the tremendous problems of cost, author time involved, and shortcomings in its capability to communicate meaningfully with the student were overcome. The fact is we do not know enough about the computer as an aid or an obstacle to learning. There is currently little evidence available to indicate the effectiveness of the CAI approach with __X__ kind of student learning subject matter __Y__ in situation __Z__. Perhaps we will be in a better position to evaluate the many CAI efforts currently underway across the country.

As mentioned in the introductory comments in this paper I believe that CAI has the potential to contribute to humanizing rather than dehumanizing education. It theoretically can provide a means to move pupil-teacher interchanges past information exchange. Students who come to the teacher already equipped with the pertinent information can more readily deal with complex concepts and relationships between them. The role of the teacher is then revised. He becomes more of a catalyst or sounding board

than an information giver. Freed from the drudgery of routine repetition teachers may be able to become true stimulators of ideas.

One last comment about the future of computer-assisted instruction and guidance. I visualize both of these applications as fitting into a total instruction program or guidance program respectively. Those functions of instruction and guidance which these systems will have been found can handle most effectively will be delegated to them. In accomplishing these ends, then, the teacher, counselor, and curriculum director must actively participate. In order for them to become involved, however, they must be trained in the capabilities of the available techniques and their mode of operation. A new breed of teachers must emerge from our teacher education institutions -- a breed that can deal effectively with the complex problems inherent in such a process.

Though I feel very strongly that the future of these computerized methods is in their value as aids to instruction and guidance rather than as independent entities, I feel just as strongly that there will be a place for them in the future of education. The notion that the one to one ratio of student to teacher or student to counselor is the ideal goal is not acceptable to me. I believe there are some major functions which can only be handled by computer-assisted devices whether a teacher or courselor is responsible for one student or one hundred students.

Whether I am proven right or wrong about these projections is relatively unimportant to me. What is important to me is that others are stimulated to fight as hard as I for an opportunity to find out.

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